Crustal evolution and petrogenesis of silicic plutonic rocks within the Oman ophiolite – petrological and geochemical investigations

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Silicic (56-79 wt. SiO_2) plutonics from mantle and crustal (plagiogranites s.l.) sections of the Oman ophiolite suggest multiple petrogenetic processes during the accretion of the Oman paleocrust at a fast-spreading ridge system, affecting major and trace elements as well as radiogenic isotopes. The mantle granites are distinctly enriched in SiO_2, K_2O, Ni and Cr but depleted in Al_2O_3, FeO, CaO and TiO_2 for a given MgO content compared to silicic crustal rocks. The mineral assemblage differs because biotite, alkalifeldspar and opaqes occur in the mantle granites but are absent in comparable crustal rocks. Trace elements display high LILE, Nb, Ta and LREE contents in the silicic plutonic mantle rocks along with an increasing depletion of middle toward the HREE relative to the crustal plagiogranites. In contrast, the silicic crustal rocks are enriched in Hf, Zr and Y compared to their mantle counterparts. Furthermore, the crustal plagiogranites display a MORB-like range in Hf and Nd isotope compositions but with slightly higher $^{87}Sr/^{86}Sr$, similar to their mafic host-rocks, whereas the mantle granites possess distinctly lower εHf, negative εNd values and in most cases very high Sr isotope ratios. We suggest formation of the silicic crustal intrusives by fractional crystallization and crustal partial melting processes during Oman ocean crust formation whereas the mantle granites are most likely related to subduction or obduction processes and thus must be younger.

TRACE: A multi-tracer analysis of shallow aquifers to improve geothermal potential assessment

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The assessment of geothermal potential for deep geothermal energy production currently relies on expensive 3D reflexion seismic methods to identify adequate fault zones and geometry of the geothermal aquifer. However, this analysis does not allow the estimation of hydraulic permeability of active faults nor provides a characterisation of the chemical properties of the deep aquifer fluid. Both factors play an important role in optimising siting of fault related geothermal wells and operation of geothermal power plants.

The TRACE project aims to combine methods from hydrogeochemistry and isotope hydrology in the analysis of shallow groundwater to develop a low cost method for deep geothermal energy exploration. The main goal is to constrain the interest area with further methods supporting geophysical exploration methods. The approach introduced in this contribution includes the measurement and evaluation of a wide range of natural isotopic and geochemical. To assess the fault permeability, the groundwater $^3He/^4He$ ratio will be analysed for mantle signatures pointing to deep water circulation and upward flux [1]. The hydrogeochemical analysis and transport modeling will be used to characterise the origin and flow path of the thermal water [2] and to assess its suitability for industrial scale energy production.

The Upper Rhine Graben was chosen as the project's study region, focusing on three different local areas with preexisting well and 2D/3D seismic data to allow for comparison and validation of the study results. Preliminary results from the first sampling campaign show promising data, indicating an area of increased interest where elevated helium ratios coincide with characteristic geochemical data, fault location and a previously known saltwater anomaly.

[1] Kennedy and van Soest (2007) *Science* **318**, 1433-1436 [2] He *et al* (1999) *Applied Geochemistry* **14**, 223-235

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